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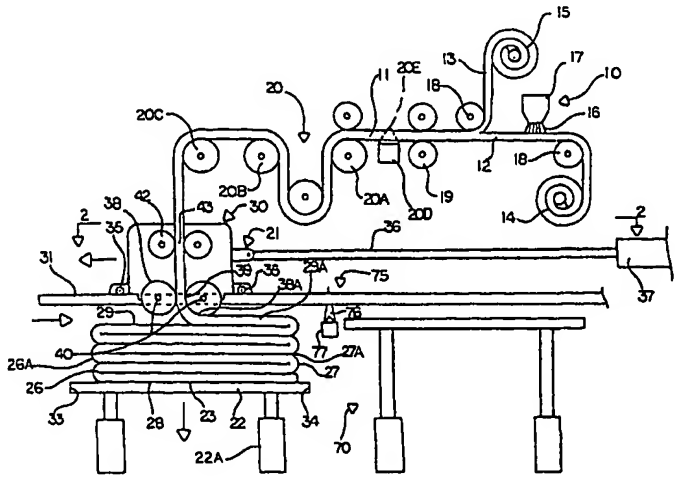

(57) Abstract

An apparatus for folding at least one strip (11) and preferably a plurality of side by side strips of material to form a package of overlying folded strip portions comprises strip guide rollers (18, 19, 20) for feeding the at least one strip (11) from a supply thereof (14, 15) onto a platform (22) which can be moved downwardly to accommodate an increasing height of the package. The folding is effected by a pair of laying rollers (38) defining a nip (39) therebetween mounted on a reciprocating carriage (30) which moves in a linear direction along a length of the package in a plane parallel to the surface (23) of the platform (22) and at right angles to the axes (40) of the laying rollers (38) such that the movement of the laying rollers (38) contains no component of movement in a direction along the length of the laying rollers (38). The drives to the carriage (30), the rollers (38) and the platform (22) are carefully controlled to effect folding of the strip to form the folded portions and to effect laying of the folded portions on the surface (23) of the platform (22).

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APPARATUS FOR PACKAGING A STRIP OF MATERIAL

This invention relates to an apparatus for forming a package of a strip.

Previously packages of a continuous strip have been formed using a technique known as "festooning" in which the strip is folded back and forth to lay a series of strip portions back and forth with each portion being folded relative to the next about a line transverse to the strip. The technique of festooning has been available for many years and is used in packaging many different types of material but particularly material of a fibrous nature such as fabric, non-woven strips and the like. In this technique, the strip is conventionally guided into a receptacle such as a cardboard box while a first reciprocating movement causes portions of the strip to be laid across the receptacle and folded back and forth and a second reciprocating movement causes the positions of the portions to be traversed relative to the receptacle transversely to the portions. Normally the receptacle comprises a rigid rectangular container at least partly of cardboard having a base and four upstanding sides.

The purpose of the festooning method is for packaging the strip for supply to a machine using the strip. Some users prefer the festooned package relative to a wound package of this type of material. The festooned package contains a much greater length of material than a spirally wound pad. The festooned package can simply be located adjacent the machine without the necessity for any unwinding or support stand. In addition, both the leading end and the tail end of the package are available at the top of the package so that a series of the packages can be connected lead to tail to act as an extended

supply. Yet further, since the material is simply laid into the package, there is less problem with tension control in the material as it is withdrawn from the package, in comparison with larger traverse wound packages where tension control of large packages can be a problem due to the inertia of the package thus requiring a driven unwind stand as well as material handling equipment for moving the large rolls. There is therefore no need when festooned packages are used for a complex unwind stand which takes up more space than may be available and involves significant cost.

Festooned packages are formed in a stiff container or box to properly enclose and contain the material and within which the material is stored during transportation for maintaining the material against compression and distortion due to the transfer of loads from surrounding packages. The cardboard container thus provides support for other similar stacked containers and prevents the transfer of loads from the stacked packages from causing excessive compression of packages at the bottom of a layer. The cardboard containers and the package structures used in the conventional arrangement however have a number of problems.

Firstly the container must be either recycled with the necessity of shipping the cardboard containers in the return direction to the supplier from the end user or they must be discarded, both at considerable expense.

Secondly the cardboard containers simply receive the material without significant compression so that there is wastage of space within the container due to the packaging of air with the material. In addition the conventional package structure does not minimize the amount of air spaces

formed in the structure. The transportation costs of the material therefore are significantly increased by the large volume of the material which provides a density which is significantly below the optimum for most efficient transport.

Thirdly the presence of the essential box during formation of the structure provides a restriction to the proper control of the strip as it is laid down since the sides of the box provide limitations to the position and movement of the guide member controlling the strip.

Fourthly it has been noted that the sides of the box which are parallel to the strips as they are laid down do not closely confine the sides of the package structure with the significant danger that the strips can fall down between the edge of the package and the box side.

In addition, the conventional technique for forming the package in which each of the strips slit from a web of supply material is individually packaged at a separate festooning station is slow and requires a large amount of floor space for the large number of stations. Also the large area covered by the stations causes a significant distance to be travelled by the strip from the slitting station to the festooning station with the potential for strip tension problems and damage to the strip.

There remains therefore a significant requirement for a package of this general type but the techniques presently available are unsatisfactory for the above reasons leaving opportunity for an improved package structure.

It is one object of the present invention, therefore, to provide an improved apparatus for forming a package of a strip or web which avoids rolling and unrolling of cylindrical rolls.

According to one aspect of the invention therefore there is provided an apparatus for folding at least one strip to form a package of overlying folded strip portions comprising:

strip feed rollers for feeding the at least one strip from a supply thereof;

a platform having a generally horizontal support surface for receiving the package thereon;

a pair of laying rollers defining a nip therebetween for receiving the at least one strip from the feed rollers and for laying the strip on the surface of the platform to form the package, the laying rollers having a length at least equal to a width of the package;

a carriage on which the laying rollers are mounted such that the laying rollers are arranged with their axes mutually parallel and parallel to the width of the package;

a guide for guiding reciprocating movement of the carriage in a linear direction along a length of the package, the direction lying in a plane parallel to the surface of the platform and the direction extending at right angles to the axes of the laying rollers such that the movement of the laying rollers contains no component of movement in a direction along the length of the laying rollers;

first drive means for rotating the laying rollers;

second drive means for driving the carriage in the reciprocating movement in said direction across the platform between two extreme positions of the movement thereof to lay the portions of the strip on the platform;

third drive means for causing relative movement in a direction at right angles to the surface of the platform between the platform and the guide for accommodating an increase in height of the package as the folded portions are folded onto the platform;

and control means for controlling the first, second and third drive means to effect folding of the strip to form the folded portions and to effect laying of the folded portions on the surface of the platform.

One embodiment of the invention will now be described in conjunction with the accompanying drawings in which:

Figure 1 is a side elevational view of a machine for manufacturing and folding a strip of a sheet material.

Figure 2 is a top plan view of the machine of Figure 1.

The machine as shown in Figures 1 and 2 includes a section 10 for forming a sheet 11 of a material to be packaged. The manufacture of the sheet 11 is shown only schematically since many different types of sheet material can be manufactured and used in the folding machine of the present invention. The type of material to be folded is not limited to the joined and bonded strips as shown but can include carpet, felt, fabric, plastics layers and other materials which can accommodate the folding action as described hereinafter.

In the example shown, the sheet 11 is formed from a lower layer 12 and an upper layer 13 each of which is provided from a respective supply 14, 15. Between the layers is applied a powder 16 from a container 17. The layers are passed over guide rollers 18 and through a nip roller system 19 so as to bond the layers together to form the sheet 11.

On the manufacturing section 10, the sheet 11 is passed through an accumulator 20 again shown schematically which allows the manufacturing process to run at a slightly different speed from the folding system and to accommodate slight changes in speed of the folding system including very temporary stops of the folding system while the manufacturing process remains continuous.

The accumulator includes rollers 20A, 20B and 20C. Between the rollers 19 and 20A can be provided a slitting bar 20D carrying a plurality of transversely spaced slitting knives 20E. The slitting knives, if provided, act upon the sheet between the rollers so as to slit the width of the sheet into a plurality of separate strips with the slits and the strips extending longitudinally. The rollers 20C include guide elements which act to guide the separated strips so that they run side by side without any overlap.

The sheet 11 in the form of the strips is supplied on the guide rollers from the manufacturing system to a folding apparatus generally indicated at 21. The apparatus comprises a platform 22 having an upper generally horizontal support surface 23 onto which the folding sheet is applied. The platform 22 is mounted on suitable support jacks 22A which allow the platform to be moved vertically so as to accommodate the increasing height of the stack of the folded lengths of the strips.

In general, the strips are folded back and forth so that side edges 24 and 25 (figure 2) of each of the strips and the sheet lie directly superposed. The back and forth folding provides a first series of fold lines 26 (figure 1) which are substantially directly superposed. A second series 27 of fold lines is

arranged opposite to the first series and again the fold lines are substantially superposed. In an alternative arrangement (not shown) they may be slightly staggered to avoid providing a height at the fold line which is higher than other areas of the stack.

The folding back and forth thus forms a generally rectangular body having a bottom 28 of the body at the horizontal platform surface 23 and a top of the body which increases in height. The top end is indicated in the partly formed condition at 29 in Figure 1 but it will be appreciated that the stack will be built up to a required height which can vary in accordance with requirements and therefore the top of this stack will in effect be formed by the end portion of the sheet which is last laid when the stack is finished.

The body further includes two ends 26A and 27A at the fold lines 26 and 27 and two sides 24A and 25A at the side edges 24 and 25. The package has a width between the sides 24A, 25A and a length defined by the length of the laid strip portions that is the distance between the ends 26A, 27A of the package.

The apparatus further includes a carriage 30 which slides on horizontal guide tracks 31 and 32 each arranged at a respective side of the platform. In Figure 2 it will be noted that the width of the sheet is substantially equal to the width of the platform although this may of course vary in dependence upon the width of the sheet required. Just outside the sides of the platform is provided the respective guide tracks 31 and 32 each in the form of a longitudinal rail which is directly horizontal and therefore directly parallel to the upper surface 23 of the platform. The guide tracks extend beyond the ends 33 and 34 of the platform so as to allow the carriage to move so that the center of the carriage is

arranged at the respective fold lines 26 and 27. The carriage includes rollers 35 which roll on or in the guide track so as to hold the carriage stable in its movement parallel to the guide tracks. The arrangement of the guide track and the rollers is only one example and it will of course be appreciated that various slide or roller guides can be provided which allow the carriage to move horizontally.

Horizontal movement of the carriage is effected by a drive rod 36 actuated by a suitable linear actuation mechanism 37 which drives the carriage back and forth between the extreme positions defined by the fold lines 26 and 27. The actuator in this embodiment is shown as a cylinder but this is of course only an example since other designs such as drive belts or cables can be provided by one skilled in the art.

The carriage is maintained stationary relative to the platform in a direction at right angles to the direction of linear movement, that is neither the platform nor the carriage are traversed in this direction so that the sheet is laid in portions with the side edges of each portion directly on top of a previous portion.

The carriage carries a pair of laying rollers 38 which are exposed at the bottom of the carriage and face downwardly toward the top layer 29 of the package body. The rollers are arranged as a pair with a nip 39 between the rollers for passage of the sheet 11 therebetween. The rollers are arranged with their axes 40 parallel and with the axes lying in a common horizontal plane parallel to the surface 23 of the platform 22. The axes are at right angles to the direction of movement. One or both of the rollers 38 is driven and in the example shown the rollers are driven by a stepping motor 44 (figure 2) with a timing belt

drive mechanism indicated at 41 communicating drive from the motor 44 to the rollers 38. As shown in the drawings, the rollers are mounted with their axes in a common horizontal plane.

In an alternative arrangement (not shown), the rollers can shift out of that plane by a tilting action of the rollers relative to the carriage or by lifting one roller relative to the other. The tilting action can be used to improve folding of the strip. The lifting of one roller ensures that it is clear of the laid strip while the other roller acts as a laying roller. Thus each roller in turn is lifted and lowered depending upon the direction of movement.

Above the rollers 38 may be provided a second pair 42 of guide rollers which form a second nip 43 through which the sheet 11 passes. The rollers 42 can also be driven by the same timing belt drive mechanism 41 to provide a synchronized feeding of the material through the nips 43 and 39 at a rate which can be varied in dependence upon the rate of driving of the stepping motor 44. The rollers 42 can cooperate with the rollers 20C to provide an accurate guiding of the sheet and particularly the strips, if the sheet is slit into the separate strips as described above.

The rollers 38 are smooth and continuous across the width of the sheet and therefore of the package without raised ribs.

The frame structure of the carriage is shown only schematically and this will generally include a pair of end plates 46 and 47 which provide suitable bearings for the rollers, and support the timing belt drive 41 and the motor 44. The carriage also includes suitable transverse elements which couple the end

plates as indicated at 48 and 49, leaving the lowermost parts of the rollers 38 exposed at the bottom of the carriage.

The screw jacks 22A, the linear actuator 37 and the stepping motor 44 are all controlled by a control device 50 which is programmed to control these elements each in dependence upon the other and each in dependence upon the thickness of the material and the intended locations of the fold lines 26 and 27.

Thus the screw jacks 22A are controlled so that the platform 22 is moved downwardly as the layers of the sheet are laid each on top of the next. The downward movement is controlled so that the lower part of the rollers 38 lies in contact with the upper most strip that is laid as indicated at 29. The rollers are driven in a direction so as to feed the material through the nip 39 and so that the material wraps around one of the rollers as indicated at 38A to form a layer 29A which is laid on top of the layer 29. The layer 29A passes around the roller 38A so it is carefully controlled by that roller as it laid onto the layer 29. The rollers 38 thus can act as lay on rollers directly depositing each portion of the sheet onto the next portion to form the stack.

The control unit 50 thus is programmed with the thickness of the material so that it properly and accurately moves the platform at the required rate to accommodate the increasing height of the stack.

However, contact between the rollers and the uppermost strip portion may not be essential and in some cases, the rollers are more preferably slightly spaced from but immediately adjacent the uppermost strip portion.

The control unit is further programmed to control the length of movement of the carriage and thus the positions of the fold lines 26 and 27. In

addition the movement of the carriage is controlled so that the acceleration from the stationary position as the carriage reverses in direction at the ends of its movement is properly managed to provide suitable forces on the carriage structure and the rollers. The velocity of the carriage is controlled so that it lays the sheet at an average rate which is substantially equal to the feed rate of the sheet from the feed rollers 19.

The control device further controls the stepping motor 44 so that the laying rollers are driven at a rate which is proportional to the instantaneous velocity of the carriage. Thus the material is fed through the nip of the lay on rollers at a rate which is equal to the rate which it is laid upon the stack. Thus the drive rate of the laying rollers decreases at the ends of movement of the carriage so as to match the deceleration and temporary halt of the movement of the carriage. The laying rollers therefore halt at each end or extreme position.

In an alternative arrangement, the rollers may not exactly halt but may continue to feed the material at a slower rate so as to push the material onto the stack and form a loop of the material at the fold line 26, 27.

The horizontal movement of the carriage ensures that the rollers remain at a substantially constant distance from the top of the stack or immediately adjacent the top of the stack so that the strip is properly laid across its full width. The rollers therefore do not move away from the stack at the ends of the stack and the strip is properly controlled as it is laid.

The apparatus preferably does not provide any gripper or tamper elements at the end positions but instead relies upon the pressure from the

rollers onto the top of the stack to form a soft crease in the strips at the nd positions.

However tampers, grippers or fold support members may be provided if a harder crease is required. These elements must of course be moved to allow the folded strip to be dropped onto the stack and therefore add considerable mechanical complexity.

The apparatus further includes a second platform 70 identical to the first platform and a second pair of grippers 71 and 72 identical to the first pair of grippers and cooperating with the second platform 70. These are arranged relative to the first platform and one side of the platform which is on the side which is longitudinal relative to the movement of the carriage. The guide tracks 31 and 32 extend across both platforms so that the carriage can be moved from one platform to the other platform.

It will be appreciated therefore that the stack is built up firstly on the first platform and when that stack is complete, the carriage is moved from its first section of movement on the track across from the first platform to the second platform to build a second stack directly on top of the second platform.

After the traverse effect from the first platform to the second platform, the strip extending across the gap generally indicated at 75 between the two platforms is slit by a slitter knife 76 carried on a track 77. After the traverse movement is made, therefore, the first stack on the first platform can be packaged and handled as described in the above mentioned related patent applications. The package is separate from the ongoing folding action by the slitting action of the knife 76. The folding action is therefore substantially

continuous and is maintained at a rate matching the manufacture of the product and the supply from the feed rollers 19.

In the embodiment illustrated, the strips are slit or cut in straight lines so that the side edges of the strips are parallel and are parallel to the second sides of the package structure when completed. The strips also lie immediately adjacent such that the whole of the side edges of the strips are in contact with the strips of the next adjacent layer. However in other embodiments, not shown, the side edges of the strips are not necessarily straight.

CLAIMS

1. An apparatus for folding at least one strip to form a package of overlying folded strip portions comprising:

strip feed rollers for feeding the at least one strip from a supply thereof;

a platform having a generally horizontal support surface for receiving the package thereon;

a pair of laying rollers defining a nip therebetween for receiving the at least one strip from the feed rollers and for laying the strip on the surface of the platform to form the package, the laying rollers having a length at least equal to a width of the package;

a carriage on which the laying rollers are mounted such that the laying rollers are arranged with their axes mutually parallel and parallel to the width of the package;

a guide for guiding reciprocating movement of the carriage in a linear direction along a length of the package, the direction lying in a plane parallel to the surface of the platform and the direction extending at right angles to the axes of the laying rollers such that the movement of the laying rollers contains no component of movement in a direction along the length of the laying rollers;

first drive means for rotating the laying rollers;

second drive means for driving the carriage in the reciprocating movement in said direction across the platform between two extreme positions of the movement thereof to lay the portions of the strip on the platform;

third drive means for causing relative movement in a direction at right angles to the surface of the platform between the platform and the guide for accommodating an increase in height of the package as the folded portions are folded onto the platform;

and control means for controlling the first, second and third drive means to effect folding of the strip to form the folded portions and to effect laying of the folded portions on the surface of the platform.

2. The apparatus according to claim 1 wherein the control means is arranged to control the first drive means such that the laying rollers are driven at a rotation rate which changes as the laying rollers move between extreme positions of movement thereof.

3. The apparatus according to claim 2 wherein the control means is arranged to control the first drive means such that the laying rollers are driven at a rotation rate which decreases as the laying rollers approach the extreme positions and increases between the extreme positions.

4. The apparatus according to claim 2 or 3 wherein the laying rollers are driven at a rotation rate which stops as the laying rollers reach the first sides of the package.

5. The apparatus according to claim 2, 3 or 4 wherein the control means is arranged to control the first drive means such that the rotation rate is substantially proportional to the linear speed of the carriage.

6. The apparatus according to any one of claims 1 to 5 wherein the third drive means is controlled such that the laying rollers are maintained in a plane relative to an uppermost laid strip portion such the rollers are immediately

adjacent the uppermost laid strip portion so as to lay a next strip portion directly onto the uppermost laid strip portion.

7. The apparatus according to any one of claims 1 to 6 wherein the feed rollers are arranged to supply a plurality of strips side by side such that the strips are folded simultaneously by the laying rollers side by side across the width of the package.

8. The apparatus according to claim 7 wherein there is provided a plurality of slitting knives which are spaced transversely of a supply web for slitting the web longitudinally to form said plurality of strips.

9. The apparatus according to any one of claims 1 to 8 wherein the laying rollers are continuous across the width of the package.

10. The apparatus according to any one of claims 1 to 9 wherein there is provided a second platform located adjacent the platform on a side thereof longitudinal of the movement of the carriage and wherein the second drive means is arranged such that the carriage is movable from a first position cooperating with the platform to a second position cooperating with the second platform.

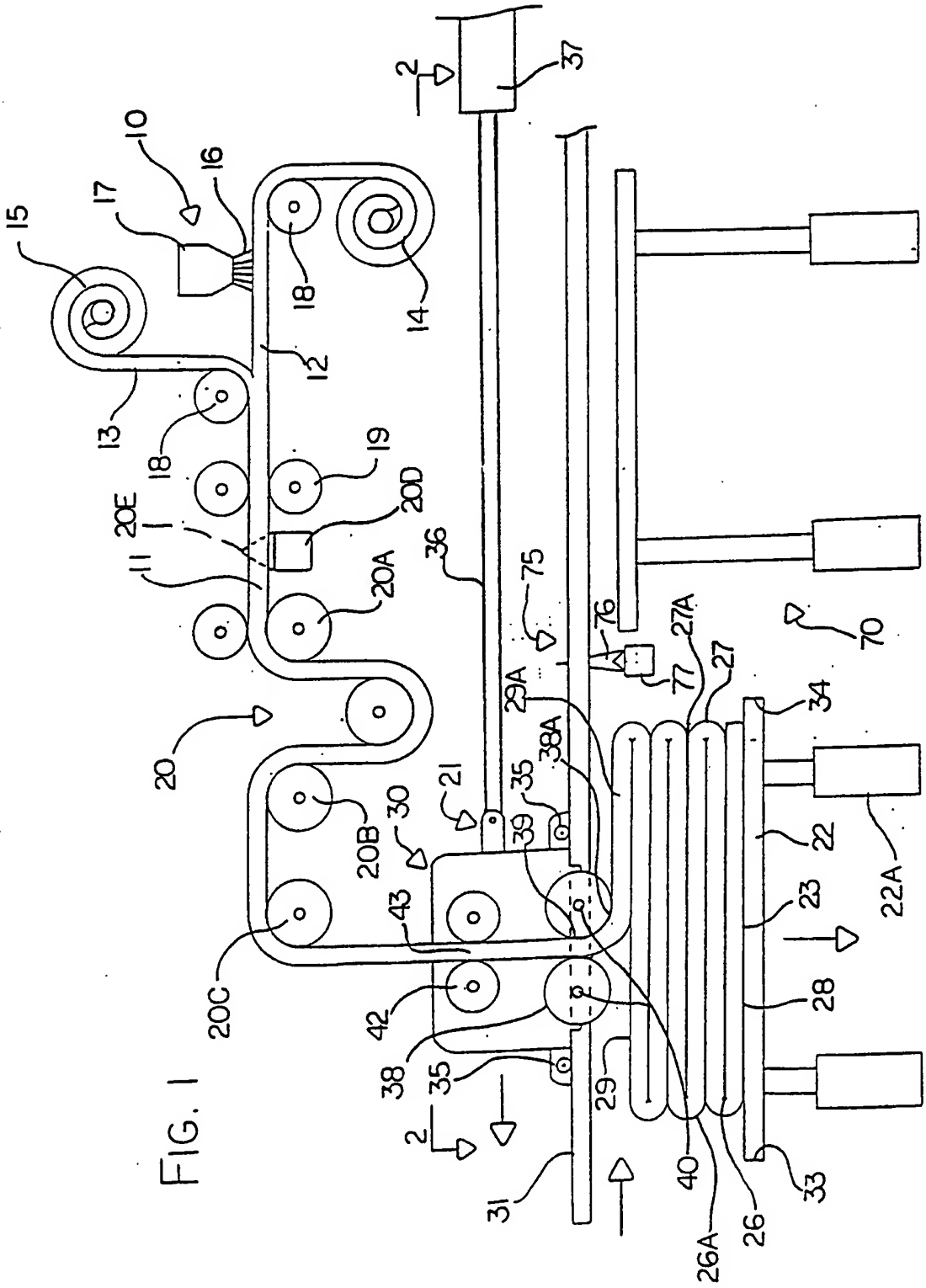
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FIG. 1

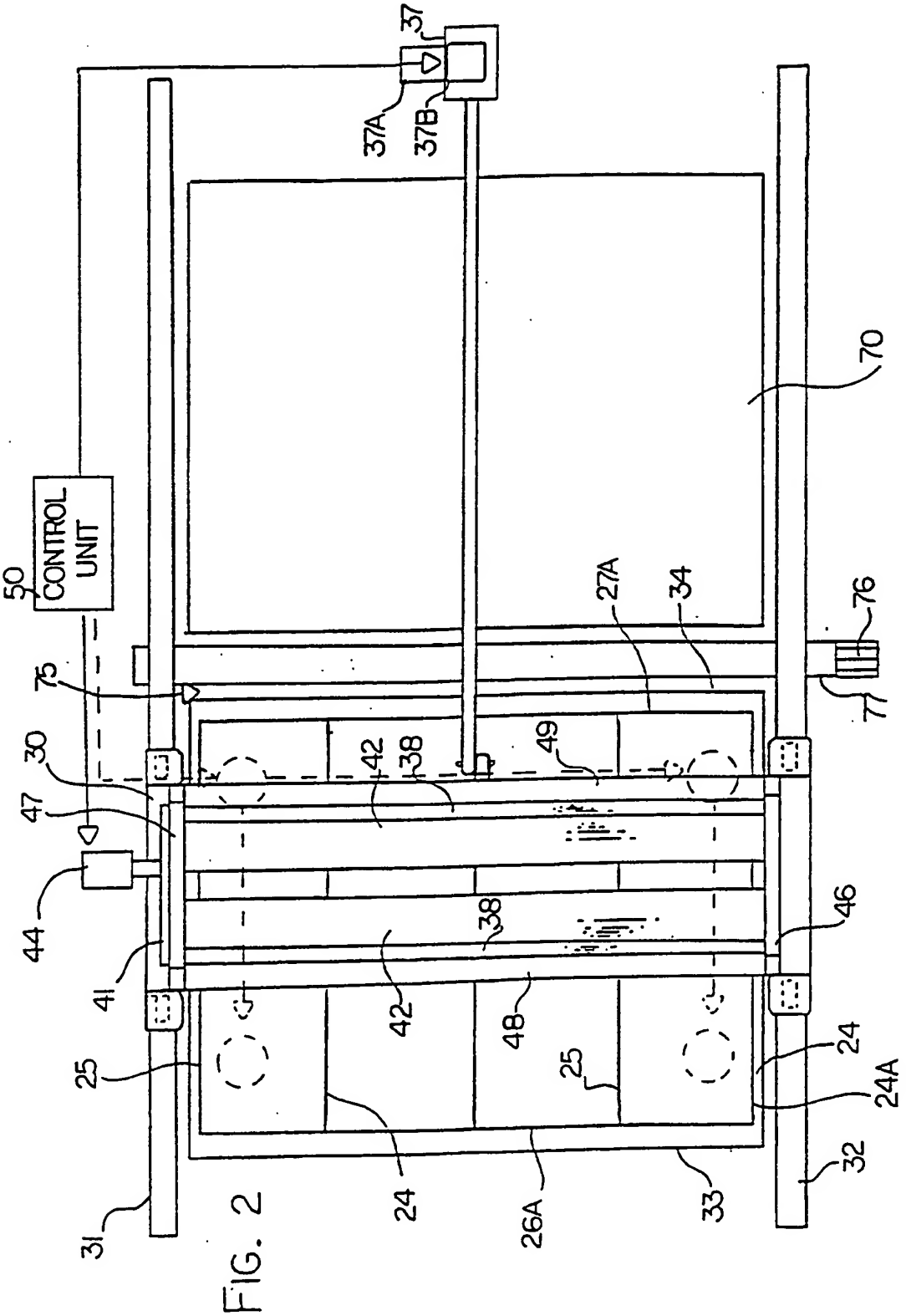
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FIG. 2

INTERNATIONAL SEARCH REPORT

Int[illegible]ional Application No
PCT/CA 98/00922

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65H45/103

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 573 958 A (P. J. BIESINGER) 4 March 1986 see column 2, line 52 - column 3, line 37; figures 1-6	1-6,9
X	DE 22 25 941 A (FA. H. KRANTZ) 13 December 1973 see page 5 - page 10; figures	1-6,9
X	DE 91 16 502 U (P. J. BIESINGER) 10 December 1992	1-6,9
A	see page 4, last paragraph - page 9, paragraph 4; figures	10
A	US 5 290 226 A (R. L. GREEN JR) 1 March 1994 see column 4, line 27 - column 5, line 43; figures	1,7,8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Inter inal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 328 556 A (D. FURIO) 20 May 1977 see the whole document	1,7,8,10

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/CA 98/00922

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